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The Institute of Molecular Evolution at the University of Miami has continued studies of the preparation and properties of thermal poly- α -amino acids and thermal polynucleotides, and also has extended studies of the behavior of microscopic units which organize spontaneously when amino acid condensates are brought into contact with water.

The rate-enhancing (catalytic) property of the proteinoids has been investigated particularly in the hydrolysis of ATP, ADP, and AMP, and in the decarboxylation of pyruvic acid. Products of the latter reaction have been shown to be carbon dioxide and acetic acid.

The catalytic type of activity of thermal polyanhydro- α -amino acids has now been reported in publications or abstracts from at least five laboratories (this laboratory; Kanazawa University; University of Bonn; Melpar, Inc.; and the Ames Research Center). Substrates and reactions which have been shown to undergo accelerated conversion, according to these reports, are the hydrolysis of p-nitrophenyl acetate, conversion of glucose to glucuronic acid, decarboxylation of glucuronic acid, decarboxylation of pyruvic acid, decarboxylation of oxaloacetic acid, and hydrolysis of ATP, ADP, and AMP. In some studies, choline esterase inhibitors have similarly affected the activity of proteinoids. In other instances, Michaelis-Menten kinetics have been recorded. The reactions show a degree of specificity depending upon composition of polymer, identity of substrate, pH, etc. In some cases, the limits to the range of conditions of the reactions have been set. (Although the activities are very much weaker than those of contemporary enzymes, these are effects which conceptually are susceptible to evolutionary enrichment.) They also promise a simple synthetic approach to identification of "active sites." In the

decarboxylation of pyruvic acid, for instance, copolymers rich in threonine are more active than others.

The assembled results lead to the inferences that proteinoids, like proteins, have many activities because of their chemical polyfunctionality. The possible variety of proteinoids is so great as to permit an extensive spectrum of relatively specific activities.

The degree of heterogeneity of thermal proteinoids has been more closely examined by fractionation of an amidated proteinoid on DEAE-cellulose columns and analysis of three of the six fractions obtained. These show amino acid compositions which are very similar one to the other and also to the analysis of the crude. A high degree of compositional uniformity throughout the polymer is inferred. Analogous results have been obtained with another proteinoid fractionated in another way. "Fingerprint" patterns of partial hydrolyzates of individual fractions also show marked similarity.

Optical resolution of amino acids by a stereoselective ligand exchange and by inoculation of supersaturated solutions of racemate have been demonstrated. The latter procedure yields L and D forms of aspartic acid, glutamic acid, glutamine, and asparagine which are almost optically pure in a single process cycle. The way in which these and other processes might have operated in the geological situation has been explained.

In collaboration with Dr. George Lewis and Mrs. Priscella Everett of the University of Miami, thermal and Leuchs proteinoids have been shown to have nutritive quality for Tetrahymena pyroformis R. This is the third species which has been shown to use thermal proteinoid nutritionally. Investigations of basic value to nutrition in space can now be approached experimentally.

Proteinoid microspheres subjected to increased pH and examined in the quartz optics microscope of Dr. Philip O'B. Montgomery of the University of Texas show the effects of Fig. 1. The polymer in the interior diffuses through the boundary, even though the boundary and interior solids are

polyamino acid of very similar composition and of the same sedimentation coefficient. These results indicate a selective action of the boundary, a result consistent with those of other earlier studies.

The proteinoid microspheres have also been shown to exhibit "motility" when asymmetric and in a solution of ATP, and to produce "buds" which grow in size. These units have also some of the "catalytic" activity of the polymer of which they are composed.

Thermal oligocytidylic acid, produced by heating cytidylic acid in polyphosphoric acid at 65°, has been shown to be partly attacked by ribonuclease and by venom phosphodiesterase. These polymers accordingly contain a significant proportion of natural linkages.

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